Late Season Fertility to Reduce Incidence and Severity of Snow Mold and Improve Spring Turfgrass Performance.
Final Report

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Methodology

This study was conducted from June, 2007 to May, 2009.

Experimental plots were established at the Cornell University Turfgrass and Landscape Research and Education Center in Ithaca, NY on a mixed stand of creeping bentgrass (70%)/annual bluegrass (30%) (*Agrostis palustris*/*Poa annua*) soil-based putting green (avg. pH = 6.9).

The research area was maintained to championship conditions, with light frequent sand topdressing applied every two to three weeks depending on growth and performance.

Plots were 4' x 6' arranged in a completely randomized experimental design with three replications. Fertilizer treatments were made on a weekly basis, starting June, 2007 ending November 2007 (Year 1) and again May, 2008 and ending November 2008 (Year 2). (Table 1). The final fertilizer treatments were variable amounts of late-season K (Table 2).

Applications were made with a handheld CO_2 sprayer at 40 psi (276 kPa) fitted with TeeJet XR8015 nozzles calibrated to deliver 2 gallons (7.6 liters) of water per 1,000 ft^2 (92.9 m^2). Nitrogen source was ammonium sulfate or urea and potassium source was potassium sulfate. No other nutrients were applied.

Table 1. Annual fertilizer rates for the treatments applied in weekly intervals during the season.

Trt#	N Rate	K Rate	Interval
1	3	0	7d
2	3	0	7d
3	3	0	7d
4	3	0.75	7d
5	3	0.75	7d
6	3	0.75	7d
7	3	1.5	7d
8	3	1.5	7d
9	3	1.5	7d
10	3	3	7d
11	3	3	7d
12	3	3	7d
13	3	6	7d
14	3	6	7d
15	3	6	7d

Table 2. Late Season fertilizer treatments applied November 2007 and 2008.

Trt#	N Rate	K Rate
1	0.5	0
2	0.5	0.125
3	0.5	0.25
4	0.5	0
5	0.5	0.25
6	0.5	0.5
7	0.5	0
8	0.5	0.5
9	0.5	1
10	0.5	0
11	0.5	1
12	0.5	2
13	0.5	0
14	0.5	2
15	0.5	4

Data were collected for turf quality, dollar spot occurrence, soil nutrients and snow mold incidence and clipping yield in Spring 2008 and 2009. Data analysis was conducted using linear mixed models with compound symmetric covariance structure to assess overall treatment effects when repeated measurements were made on the same experimental unit over time. Treatment differences at individual measurement events were evaluated using analysis of variance and Fisher's protected least significant difference (LSD). The MIXED and

GLM procedures in SAS/STAT software version 9.1 (SAS, Cary, NC) were used to perform the analyses. There were no significant differences between years and therefore most data were pooled and analyzed as one data set.

Results

Soil Analysis

Soil samples were taken in November 2008 and 2009 (2/plot, 6/treatment, combined for a total of 15 composite samples), to a depth of approximately 4 inches. Analysis was performed by Brookside Laboratories; results in Table 3 using Mehlich-3 extraction.

The soil nutrient analysis indicates that most of the plots are well below the recommended sufficiency range published in the literature for both creeping bentgrass and annual bluegrass. There were significant differences for potassium levels but only at the 6 lb. annual rate.

Table 3. Two-year soil nutrient analysis.

Trt	pH	%OM	P ppm	Ca ppm	Mg ppm	K ppm	Na ppm	B ppm	Fe ppm	Mn ppm	Cu ppm	Zn ppm	Al ppm
1	7.0	2.2	77	1475	115	58	31	0.21	174	37	1.15	2.87	687
2	6.7	2.2	87	2035	127	59	32	0.33	183	31	1.17	6.25	646
3	7.0	2.1	85	1547	112	62	21	0.25	178	32	1.18	6.21	631
4	7.0	2.25	82	1786	115	61	30	0.31	186	35	1.12	7.56	621
5	7.0	2.23	82	1465	108	60	27	0.23	179	33	1.12	6.89	601
6	6.9	2.24	80	1589	105	65	29	0.31	212	37	1.02	3.25	625
7	7.1	2.43	79	1625	122	72	27	0.27	183	35	1.10	6.01	611
8	6.7	2.24	77	1472	115	67	29	0.31	192	36	0.99	6.22	645
9	7.1	2.15	80	1489	120	75	31	0.35	178	31	1.05	3.55	621
10	6.7	2.17	81	1645	121	77	27	0.58	172	33	1.12	2.41	602
11	7.2	2.10	81	1547	118	73	29	0.41	171	35	0.92	6.25	635
12	6.9	2.05	87	1389	108	71	22	0.31	188	34	0.97	5.22	625
13	7.2	2.25	80	1954	117	128	22	0.34	185	37	1.05	7.12	551
14	7.1	2.20	92	1721	118	135	21	0.32	187	36	1.11	8.91	687
15	7.1	2.15	70	1364	122	125	27	0.31	185	37	1.01	4.44	693

Turf Quality

Turf quality was assessed on seven occasions using a scale of 1 to 9; where 1 = poor quality, 9 = excellent quality, and 6 = acceptable quality. There were no significant differences in turf quality among the treatments (Table 4) across the growing season in the two-year study. The data are presented as monthly means.

In spite of the low potassium levels measured in the treatments there was no effect of potassium fertilizer applications on turfgrass quality ratings during the growing seasons. The lack of effect on turfgrass quality is consistent with previous potassium research conducted at Cornell University. This continues to suggest the inefficiency associated with regular potassium fertilizer applications in spite of the very low nutrient levels (based on current industry interpretations).

Table 4. Effect of nitrogen/potassium fertility on turf quality.

Seasonal Rates		Late Season Rates		Turfgrass Quality Ratings						
N	K	N	K	May	Jun	July	Aug	Sept.	Oct.	Nov
3	0	0.5	0	7.0	7.1	6.6	6.8	6.9	6.7	6.4
3	0	0.5	0.125	6.9	7.1	6.6	7.3	7.0	6.7	6.7
3	0	0.5	0.25	7.2	7.4	6.8	7.2	6.9	6.7	6.7
3	0.75	0.5	0	7.1	7.2	6.6	6.8	7.0	6.7	6.5
3	0.75	0.5	0.25	7.1	6.8	6.3	6.5	6.9	6.7	6.3
3	0.75	0.5	0.5	7.4	7.1	6.7	7.2	7.0	6.6	6.4
3	1.5	0.5	0	6.7	6.9	6.1	6.6	7.2	6.6	5.9
3	1.5	0.5	0.5	6.7	7.0	6.2	6.5	6.8	6.4	5.8
3	1.5	0.5	1	7.5	7.2	7.0	7.0	7.0	6.6	6.5
3	3	0.5	0	6.9	7.0	6.5	6.6	6.8	6.5	5.6
3	3	0.5	1	6.7	7.0	6.4	6.4	6.8	6.6	6.0
3	3	0.5	2	7.0	7.2	6.6	6.5	7.0	6.6	6.5
3	6	0.5	0	7.4	7.1	6.8	6.7	6.9	6.6	6.7
3	6	0.5	2	6.6	7.0	6.7	6.9	6.8	6.5	5.8
3	6	0.5	4	6.6	7.1	6.8	6.4	7.1	6.6	6.1
			LSD (0.05)	NS	NS	NS	NS	NS	NS	NS

Dollar Spot (2007)

Dollar spot infestation was assessed twice during the study by counting the number of spots per plot. There were no significant differences among treatments on either date, nor when averaged over both dates. (Table 5 & 6). The two infestations of dollar spot did not appear to be associated with potassium treatment. However there appeared to a trend of increasing dollar spot as potassium was added.
There were no significant dollar spot infestations in 2008.

Table 5. Effect of nitrogen/potassium fertility on dollar spot incidence.

Seasonal Rates		Late Season Rates		# Dollar Spots/Plot	
N	K	N	K	12-Sept	27-Sept
3	0	0.5	0	6.3	12.0
3	0	0.5	0.125	4.3	7.3
3	0	0.5	0.25	2.0	6.3
3	0.75	0.5	0	2.3	11.3
3	0.75	0.5	0.25	4.0	15.0
3	0.75	0.5	0.5	7.7	13.7
3	1.5	0.5	0	5.0	16.0
3	1.5	0.5	0.5	7.3	21.3
3	1.5	0.5	1	4.7	12.3
3	3	0.5	0	5.7	21.3
3	3	0.5	1	4.3	14.7
3	3	0.5	2	4.7	14.0
3	6	0.5	0	3.7	9.0
3	6	0.5	2	5.0	16.0
3	6	0.5	4	5.3	17.0

Table 6. Overall means for dollar spot incidence.

Treatment	DS
1	9.2
2	5.8
3	4.2
4	6.8
5	9.5
6	10.7
7	10.5
8	14.3
9	8.5
10	13.5
11	9.5
12	9.3
13	6.3
14	10.5
15	11.2

Snow Mold

Gray and pink snow mold infestation were assessed twice during spring 2008 and twice in Spring 2009 by estimating the percent area per plot infected. Snow mold incidence was increased at increasing potassium application rates. In fact there was a significant effect of the late season potassium rate on snow mold incidence, i.e., as late season rate increased snow mold incidence increased. There was also an obvious reduction in recovery associated with high seasonal and late season potassium applications.

Table 7. Effect of nitrogen/potassium fertility on snow mold incidence.

Seasonal Rates		Late Season Rates		% plot infected with Snow Mold	
N	K	N	K	March	April
3	0	0.5	0	0.0	0.0
3	0	0.5	0.125	0.0	0.0
3	0	0.5	0.25	4.7	0.0
3	0.75	0.5	0	4.7	0.9
3	0.75	0.5	0.25	11.2	4.7
3	0.75	0.5	0.5	15.8	6.5
3	1.5	0.5	0	4.7	0.0
3	1.5	0.5	0.5	9.3	1.9
3	1.5	0.5	1	11.2	6.5
3	3	0.5	0	9.3	9.3
3	3	0.5	1	14.0	11.2
3	3	0.5	2	18.6	13.0
3	6	0.5	0	11.2	9.3
3	6	0.5	2	27.9	14.0
3	6	0.5	4	37.2	20.5
			LSD(0.05)	3.1	2.1

Clippings

Clippings were collected on April 21, 2008 and April 27, 2009. Fresh weights and dry weights were recorded. Dry weight data are presented here. (Table 8).

We were surprised to see the lack of effect on clipping production as it has been observed in other CU research as well as reported in studies in the 1980's.

It appears the differences in snow mold infection and recovery cannot be explained by alteration of vertical growth as had been speculated. There does not appear to be antagonism of spring growth from potassium applications at the 3 lb. annual N rate.

Table 8. Effect of nitrogen/potassium on clipping dry weights.

Treatment	Dry Wt. grams	Dry Wt. grams
	21-Apr	27-April
1	9.7	10.0
2	9.4	9.7
3	10.7	11.0
4	10.5	10.8
5	8.5	8.8
6	8.0	8.2
7	9.8	10.1
8	8.6	8.9
9	8.3	8.5
10	9.6	9.9
11	9.0	9.3
12	7.7	7.9
13	9.6	9.9
14	9.6	9.9
15	7.7	7.9
LSD (p=0.05)	NS	NS

Summary

This two-year study has confirmed some initial observations associated with increased potassium fertilization from previous potassium research at Cornell University.

1. We observed no differences in turfgrass quality ratings during the two growing season associated with potassium treatment.
2. We observed slight differences in soil K levels over the two years but only associated with the highest late season K rate application and could not correlate these levels to any other response.
3. We observed increased snow mold as K fertilization levels were increased during and at the end of the season.

One previous observation that was not confirmed is the reduced spring growth associated with elevated potassium application rates. While this observation had been speculative we expected the reduced recovery associated with the high potassium applications would correlate to reduced clipping production.

We are currently conducting several basic studies attempting to further understand the relationship among potassium fertilization, potassium uptake and snow mold.